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Investment Priorities for the Development of Mozambique's Seed System

by

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ACRONYMS

Acronym	English	Portuguese
AFRICARE	*Non-governmental Organization*	*Organização não Governamental*
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa	Associação para o Fortalecimento de Investigação Agrícola em África de Leste e c Central
CARE	*Non-governmental Organization*	*Organização não Governamental*
CIMMYT	International Center for Maize and Wheat Improvement	Centro Internacional de Melhoramento de Milho e Trigo
CLUSA	Cooperative League of United States of America	Liga Cooperativa dos Estados Unidos de America
CNS	National Seed Committee	Comité Nacional de Sementes
DANIDA	Danish non-governmental Organization	
DAP	Department of Policy Analysis	Departamento de Análise de Políticas
DE	Directorate of Economics	Direcção de Economia
DINA	National Directorate of Agriculture	Direcção Nacional de Agricultura
DPA	Provincial Directorate of Agriculture	Direcção Provincial de Agricultura
DS	Seed Department	Departamento de Sementes
FAO	Food and Agriculture Organization of the United Nations	Organização das Nações Unidas para Agricultura e Alimentação
GDP	Gross Domestic Product	PIB: Produto Interno Bruto
GTZ	German Technical Assistance	Assistência Técnica Alemão
ICRISAT	International Crop Research Institute for Semi-Arid Tropics	Instituto Internacional de Investigação para os Trópicos Semi-Áridos
INE	National Institute of Statistics	Instituto Nacional de Estatística
INIA	National Institute for Agronomic Investigation	Instituto Nacional de Investigação Agronómica

IITA	International Institute of Tropical Agriculture	Instituto Internacional de Agricultura Tropical
MADER	Ministry of Agriculture and Rural Development	Ministério da Agricultura e Desenvolvimento Rural
PANNAR	New Private Seed Company in Mozambique that receives support from PANNAR-South Africa	Nova Companhia Privada de Sementes em Moçambique que recebe apoio da PANNAR-África de Sul
SADC	Southern African Development Community	Comunidade de Desenvolvimento da África Austral
SARRNET	Southern Africa Roots and Tubers Network	Rede Austral de Raízes e Tubérculos
SEEDCO	Seed Company based in Zimbabwe	Companhia de Sementes de Zimbabwe
SEMOC	Seed Company of Mozambique	Sementes de Moçambique
SNS	National Seed Service	Serviço Nacional de Sementes

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1. Introduction

Improved seed offers one of the easiest and more reliable means to increase national agricultural income. Better seed varieties contribute directly to gains in agricultural productivity. This includes gains in average yields, and, often, in the stability of crop production in the event of drought. Improved varieties are generally more responsive to agricultural inputs, offering multiplied returns to complementary investments in crop management. Well-chosen seed varieties can also increase the efficiency of agro-industrial processing, and the quality of processed products. In consequence, farmers, traders, processors and consumers all achieve a measure of economic benefit.

One of the great advantages of improved seed is the relative easy transferability of this agricultural technology. New varieties can be quickly distributed to large numbers of farmers. Open and self-pollinated seed crops can be further disseminated in trade between neighboring farm households. The process of adoption is generally simple. Most new seeds readily substitute for older varieties without complicated changes in crop management.

One consequence is that the returns to investments in the development and dissemination of new crop varieties are commonly measured at rates far higher than most alternative agricultural technology investments (Howard et al. 2001; Maredia et al. 1998; Masters et al. 1998). Higher returns are achieved when investments in seed multiplication and distribution quickly follow variety release (Rohrbach et al., 1997).

Paradoxically, the level of investment in many national seed systems tends to be low. New varieties are developed, but never released. Varieties that are released are not being multiplied. If seed stocks are multiplied, these are not reaching the majority of small-scale farmers. Substantial gains in agricultural productivity and farm incomes are foregone.

Mozambique is one of these many countries under-investing in its national seed system. Rough estimates outlined in this report indicate the country is losing at least US$260 million per year in agricultural incomes. This is a simple measure of the reduced levels of productivity resulting from the failure to disseminate varieties of key crops[1] that have been developed or tested by the national research service, and found to offer higher yields. Many of these varieties are simply not reaching the majority of Mozambique's farmers.

This policy brief outlines a number of steps for strengthening Mozambique's seed system based on interviews conducted in the year 2000 and a review of existing literature. These include measures to speed the distribution of new seed varieties, and to place this distribution on a more sustainable footing. Recommendations are offered for strategies to better link variety development with seed multiplication and distribution. Proposals are highlighted to improve the complementarities of public and commercial investments in the national seed system. Opportunities for improving the efficiency of seed delivery through emergency relief programs are briefly reviewed. The paper concludes with a call for greater dialogue across all elements of the national seed sector in order to speed the pursuit of a common agenda for seed system development.

[1] The key crops for which calculations could be made include: maize, sorghum, millet, rice, beans, groundnuts, cassava, and sweetpotato.

Some of the recommendations offered in this paper are linked with the results of the June 1999 national workshop on seed system development (organized by the Instituto Nacional de Investigação Agronómica (INIA)). This meeting brought together all the key stakeholders in the national seed system including representatives of government, the private sector, non-governmental organizations, international agricultural research institutes, and donors to discuss opportunities for improving the flow of improved seed to farmers in Mozambique. The workshop examined issues of seed production and distribution, and developed an Action Plan (Anon 1999) for the further development of the national seed system. However, only limited progress has been made toward the implementation of this Action Plan. Commitments to invest more resources in developing the national seed system need to be reaffirmed.

2. Justification: Seed Policy as a Question of Investment Priorities

The economic costs of limited or late distribution of improved seed varieties are substantial. Rough estimates suggest Mozambique is annually losing up to US$77 million in productivity gains from the failure of the national seed system to disseminate known grain and grain legume seed currently identified on the national variety registration list. In addition, the country is losing US$185 million as a result of the limited distribution of improved manioc and sweetpotato planting material (Table 1). Substantially larger sums are being lost if one considers the complementary costs of continuing food insecurity and poverty. The direct costs of the limited distribution of new varieties translate into an annual average loss of US$97 (Mt1.2 million) for each farming household in the country (Table 2)[2]. This is equivalent to one-half the level of average per capita incomes (INE, 1999).

The benefits of investing in distributing improved seed vary by crop and by province (Annex 1). The highest returns occur to manioc and maize because these are the most widely grown crops throughout the country. Moreover, benefits are biased towards provinces with higher agro-ecological potential. For example, Nampula province receives 37,5% of the total estimated net annual additional benefit, even though only 20% of the rural population lives in that province. However, the annual benefit per household is significant even in provinces with lower agricultural potential. In these poorer regions, net gains in food security are important. Estimates of additional annual per household benefit range from a low of $US45 per household in Tete province to a high of $USD 159 in Nampula province (Table 2).

Most of losses result because of the failure of the national seed system to provide the majority of Mozambique's farmers with high quality seeds at affordable prices. The extent of the problem varies by crop. For instance, virtually no sorghum or pearl millet seed are being multiplied in Mozambique. In comparison, in many parts of the country maize seed production and distribution has been successful, though largely as a consequence of emergency distributions. Large quantities of two improved varieties, Manica and Matuba were distributed to farmers through many parts of the country in the 1990s. Yet most of this seed is now imported, and the majority of Mozambique's maize producers still lack consistent access to these and other improved seed stocks.

What is necessary to consistently deliver seed of improved varieties of most major food and cash crops into the hands of Mozambique's farmers? An evolving set of better varieties needs to be identified and registered for distribution to farmers in the country. Once registered, public and private investments are needed to maintain stocks of high quality breeder seed, and to multiply this into larger foundation and commercial seed stocks that can be distributed to farmers. The national seed system may encompass multiple delivery channels depending on the crop, region and farmer targeted. High payoffs are likely obtained from the rapid delivery of improved varieties through relief and development programs. However, a sustainable seed system also requires complementary investments in developing commercial trade channels. The seed sector also needs a system of seed quality control capable of efficiently and rapidly diagnosing problems of seed quality and sanctioning instances of market fraud. Finally, monitoring systems are needed to diagnose market failures and evaluate the need for targeted public investment.

Seed policy cannot simply be viewed as a series of regulations designed to protect the seed producer or consumer. Instead, seed policy should be viewed as a positive strategy

[2] Calculated at 1998/99 average exchange rate of 12,400 Meticais (MT) per $USD.

targeting the delivery of better seeds to as wide a market of farmers as possible. The result should be higher rates of adoption of a shifting array of improving varieties.

Trade-offs need to be considered between the costs of regulation, and the costs of delayed or limited access to new varieties. Policy makers encounter the difficult choice regarding the level of regulation necessary to protect farmers from the possibility of receiving poor quality seed while encouraging the rapid distribution of new varieties.Policy makers need to define priorities underlying the allocation of public investments in the system. Should more funds be allocated to crop breeding, or to the production and distribution of breeder and foundation seed, or to the establishment of laboratories to test seed quality, or the development of seed markets?

Some aspects of seed policy are crop specific. Policy makers need to distinguish which seed crops have commercial potential, and which require stronger public support for their distribution. Classic "private" goods are those that the seller can easily maintain control of, and individual buyers need to re-purchase on a regular basis. In the seed sector, vegetable seeds, hybrid maize, hybrid sunflower, and tobacco easily fall within that category. At the other extreme, vegetatively propagated crops (manioc and sweetpotato) are classic "public" sector goods as farmers can easily expand their own fields or provide planting material to neighbors. There is little to no incentive to re-purchase a variety they already possess. Moreover, if farmers follow basic rotation recommendations and know how to select disease-free planting material, the initial yield gain from the improved material can be maintained for many years.

The remaining crops listed in Table 1 require more detailed consideration. Farmers typically do not purchase open-pollinated varieties on an annual basis, yet yields may decline significantly if seed is not renewed every 3 to 5 years. The seed of self-pollinated crops may need to be renewed at similar intervals is disease pressures are high. Seed demand will also depend on the probability of losses associated with drought and floods.

Ideally, smallholder farmers need to have access to seed at 2 to 3 times the cost of what they will receive for the grain they produce. In Mozambique, price ratios of seed to grain produced, particularly for certified seed from the formal sector, often are much higher, discouraging adoption of improved seed on a large scale. During the 1998/99 agricultural season, average seed to grain price ratios ranged from 2,4 for rice to 6,7 for millet (Table 3).

Farmers also consider the aggregate costs of seed when making their investment decisions. These vary by sowing rates. For instance, the low seeding rate for millet (5 kg/ha) means that the total cost for planting one hectare of millet is approximately US$4 (50.000 MT). At the other extreme, the high seeding rate for broadcasting rice (120 kg/ha) negates much of the benefit of the reasonable seed to grain price ratio, requiring US$58 (714.000 MT) to plant one hectare of rice (Table 3). Both sugar beans and groundnuts suffer from higher per kilogram seed cost and high sowing rates, with per hectare total seeding cost above $100 USD (1.200.000 MT in 1998/99). In such cases, small-scale farmers are most likely to expand the area the plant to new varieties more gradually.

Recommendations

1. Allocation of funding for agricultural development should prioritize the goal of increasing the access of farmers to quality seed. Priority should be given to interventions offering larger economic gains derived from rising adoption rates.
2. Seed regulations should emphasize improving seed supply, rather than simply protecting farmers from faulty seed.

3. Policy should distinguish between seeds that can be commercialized, and those likely to require longer term public support for their distribution. These may vary for different parts of the country.

3. Registration Process for New Varieties has been a Constraint to Farmer Access

The Government of Mozambique periodically publishes a list of seed varieties that can legally be distributed or sold in the country. To get on this list, a new variety must first be officially registered and released[3]. This is the responsibility of the National Seed Committee (Comité Nacional de Sementes ou CNS). The CNS has appointed a sub-committee to handle the technical details of varietal registration and release. However, the results of the deliberations of this sub-committee must then be ratified by the full seeds committee before their publication.

Variety release requires at least 3 years of testing on research stations and on-farm in country.[4] A new seed variety must be proven to offer improvements in productivity or quality traits compared to existing varieties. The variety must also be shown to have limited susceptibility to major pests and diseases. Data on taste or processing qualities are advantageous, though not required.[5]

The variety release sub-committee of the CNS deliberates on proposed releases, and then forwards its findings for ratification by the full committee. The release must then be cited in a national variety registration listing published in the *Boletim Nacional de República*. The frequency of this publication is not specified. Mozambique last published a list of registered varieties in 1995. However, this listing is currently in the process of being up-dated.

While this system of seed release and registration appears logical and efficient, this has been difficult to implement in practice. The CNS is mandated to meet at least twice each year. However, during the past three years, the Committee has met only twice – in October 1999 and in January 2001. It appears that the scheduling of meetings is complicated by the expectation that the Minister of Agriculture chairs these meetings. These meetings are also expected to include 12 additional members: 9 from the government (of which 6 are from the Ministry of Agriculture and Rural Development), one from a parastatal (Mozambique Cereal Institute), one from the private sector (SEMOC), one representing associations of seed producers (APROSEL), and one from Eduardo Mondlane University. There is no representation of non-governmental organizations involved in seed production, but the president of the committee can invite other participants when the topic justifies their presence. This presents a complex scheduling problem unless the delegation of authority is significant. The failure to update the variety registration list may be a direct result of this lack of meetings.

The registration of many of the varieties on the 1995 listing was based more on the fact that these varieties were already being distributed and sold in the country, than on performance data in experimental trials. This was a useful concession to the desperate need for seed imports to cope with problems of post-war resettlement, floods and drought. Since all of the varieties being imported had already been registered for sale in neighboring countries, the risks of distributing non-adapted varieties was reduced.

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[3] In general, registration encompasses the identification of the existence of a unique variety, and the declaration of an associated property right. A variety is released when the government-led seed committee allows this to be distributed or sold in the country. This decision is commonly based on the results of national variety trials. In some countries, a variety may be registered for sale without release. This practice is used in the United States. In the European Union, varieties registered in one country are automatically eligible for sale anywhere in the European Community.

[4] However, many seed sector participants remain uncertain about the number of years and types of testing actually required.

[5] It may be useful to clarify these standards in order to ensure consistent data collection and evaluation.

The variety release sub-committee of the CNS met several times in 1999 and 2000. However, up to a year later, the varieties mandated for release during these meetings still cannot be legally sold because no new variety registration list has been published. The newly proposed variety listing is said to be confidential until this is published.

In effect, no new seed varieties have been legally sanctioned for distribution or sale in Mozambique since 1995. In comparison, the seed industry in South Africa has released over 30 new crop varieties during the last 5 years.

The value of the listing is further undermined by the fact that many of the varieties on the 1995 registration list are not currently available for sale or distribution in Mozambique. Available estimates suggest that only 44 of 120 varieties on the 1995 registration list are even potentially available for sale. Foundation seed may exist in Mozambique for less than 10 of these varieties, though foundation seed stocks of many of the others are maintained by neighboring countries.

The significance of the listing is also brought into question by the fact that an estimated 14 seed varieties are not on any variety registration list (either the 1995 listing or the new draft listing) yet are currently being sold in the country (Table 4). In effect, delays in the release of new varieties and similar delays in the publication of a new variety registration list have encouraged seed producers and importers to introduce a growing set of new varieties without explicit government sanction. Since virtually all of these varieties have been well tested in neighboring countries with similar agro-ecologies, there is no evidence that this places Mozambique at a particular disadvantage. Some have even been tested and shown to perform well in Mozambique. If national seed regulations were enforced, however, Mozambique's farmers would lose access to these seeds.

Two policy questions arise in this context: a) should the results of trials from neighboring countries with similar agro-ecologies be permitted for use in deliberations about varietal release and b) should formal government release even be required.

In principle, the practice of enforcing variety release procedures is seen as a means to protect farmers from varieties unsuited to a national agro-ecology. Yet agro-ecologies do not follow political boundaries. A brief examination of the official 1995 registration list shows this to be dominated by maize, sorghum, millet, and groundnut varieties that have also been released or registered for sale in neighboring countries (Table 5). This includes 40% of the maize varieties, 50% of the sorghum varieties and 75% of the groundnut varieties on the list. Further, many of the varieties developed by INIA originated from germplasm developed in other African countries by international agricultural research centers like ICRISAT, IITA and CIMMYT. There is little doubt that INIA's breeding and variety testing efforts can improve the identification of seed varieties suited to the Mozambican agro-ecology. However, the evidence of variety spillover from neighboring countries also suggests the justification for accounting for regional performance when allowing a given variety to be sold in Mozambique.

Most developed countries do not have strict release policies. While variety registration is maintained to track property rights to germplasm, seed markets are founded on the principle of seed choice. Seed policy makers might consider maintaining national release procedures for new seed varieties developed by national breeders. But Mozambique could also simply accept the results of variety release and registration in neighboring countries with similar agro-ecologies.

Mozambique's farmers may benefit most from the re-examination of the nation's regulatory framework in the context of its experience during the past five years. A liberal seed trade policy will shorten the period of time before farmers gain access to new varieties, and offer a wider range of variety choices to the nation's farmers.

Ultimately, reciprocal arrangements for variety registration (as currently prevail in the European Union) could be sought across the SADC region. Common registration lists would facilitate regional seed trade, and improve the availability of seed stocks suited to Mozambique's needs following periods of drought or flooding.

Recommendations

1. Restructure the variety release procedure to ensure that the national seeds committee meets at least once per year and publishes a revised variety registration list within one month of its deliberations.

2. Consider dropping formal variety release, or maintain this for government-bred varieties only. Allow the variety release committee to consider evidence from trials in neighboring countries.

3. Ease the registration of varieties that have been successfully released or registered for sale in neighboring SADC countries.

4. Restructure the *Comité Nacional de Sementes* to ensure this plays a stronger role in facilitating the development of the national seed sector.

4. Breeder and Foundation Seed Unavailable for Most Varieties

The release and registration of a variety for distribution in Mozambique does not ensure that seed will be made available. In fact, no breeder seed[6] exists *in Mozambique* for at least 70% of the 120 varieties on the 1995 seed registration list. Plant breeders and national research services outside of Mozambique are maintaining breeder seed stocks of some of these varieties. However, the breeder seed stocks of some varieties developed in Mozambique are simply no longer available (Table 4). In effect, these are dead varieties. While it is unusual to lose breeder seed of varieties registered for sale, it is expected that the registration list will change over time. If breeder seed of any particular variety is not available, it is appropriate that this be removed from the registration list.

Available evidence indicates that there is no breeder seed available in country for 23% of the varieties appearing on the newly drafted registration list (Table 4). However, seed stocks of most of these varieties exist outside the country.

Breeder seed should be produced and regularly maintained by the breeder or company responsible for the development of the variety. This includes the regeneration of seed stocks available in storage. By implication, a portion of the resources allocated to crop breeding must normally be allocated to the maintenance of breeder seed stocks. Yet, apparently, this is not consistently happening in Mozambique. As budgets for the national crop breeding program have been cut, the capacity of the research service to maintain breeder seed stocks has been severely threatened. The first inclination of plant breeders is to work on developing new varieties, rather than maintain seed stocks of older varieties. Yet without such seed stocks, the essential foundation of the breeding program is threatened. The maintenance of breeder seed must be a national priority.

The next stage of seed multiplication for distribution is variously identified as basic or foundation[7] seed production. Foundation seed is normally maintained by private seed companies during the process of bulking larger seed lots for commercial sale. But this strategy assumes the existence of a large and competitive seed industry. The one company producing seed in country, SEMOC, currently only maintains production and marketing programs for maize and rice.

Larger amounts of foundation seed are available in Mozambique only for a few of the maize varieties developed in the country. The seed company SEMOC holds a financial incentive to maintain these stocks because of the regular demand for varieties like Matuba and Manica in relief programs.

INIA needs to take greater responsibility for maintaining foundation seed stocks of most of Mozambique's registered varieties, particularly those developed in country and unavailable on the regional market. Currently, INIA only holds foundation seed for a handful of varieties of groundnut and sorghum (Table 3).

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[6] Breeder seed (sometimes called pre-basic seed) is the smallest and purest category of genetic seed stock. This generally encompasses 50g to 50 kg of seed maintained by breeders for research purposes, and as an initial source of seed for larger-scale multiplication.

[7] Foundation seed (sometimes called basic seed) is commonly multiplied in steps leading to the production of commercial seed targeted for sale or distribution to farmers. The number of steps depends on the seed to 'grain' multiplication ratio of the variety, and size of the operation. In general, foundation seed encompasses seed lots ranging from 50 kg to 5 mt. However, it is common for larger lots of foundation seed of new varieties to be delivered direct to farmers.

Limited quantities of foundation seed stocks are also informally maintained by NGOs. However, the existence of this seed is difficult to track because neither INIA, nor the National Directorate of Agriculture, maintain lists of the quantities and types of seed stocks publicly available.

Most of the seed being sold in Mozambique is derived from foundation seed stocks built and maintained outside the country. This links foundation and commercial seed production with the demands of the commercial market. If a commercial market for a particular variety is perceived to exist, either for sales through retail trade or relief programs, the seed may be produced. If the external company does not perceive any commercial demand for a variety, the seed may not be available. Seed companies in neighboring countries hold little interest in most varieties registered for sale in Mozambique.

The second risk of relying heavily on regionally focused seed companies is the likelihood they will concentrate on promoting varieties developed for the wider regional market. The SEEDCO or PANNAR, for example, are more likely to maintain seed stocks of varieties targeted for sale in several countries, rather than those suitable only for a limited and uncertain market in Mozambique. These seed companies also have a commercial incentive to promote sales of hybrid, as opposed to open pollinated, seed. Mozambique does not maintain a hybrid crop breeding program.

By inference, if Mozambique wants to provide its farmers with access to a wider range of locally produced open pollinated varieties, a large share of foundation seed stocks need to be produced and maintained in country. Without a competitive seed industry, these probably need to be financed through public investments. The Ministry of Agriculture will need to prioritize these investments in order to improve adoption levels of new varieties for most crops other than maize. As a larger, private seed industry develops, the need for these public investments may decline.

The task of producing foundation seed stocks for less commercialized seed crops should logically be given to INIA. Yet the capacity of the national research service even to maintain breeder seed stocks is deficient. The effort to maintain foundation seed stocks of most released varieties would stretch this capacity even further.

The severity of these constraints is evident in the recent history of rice seed production in the country. Prior to 1999, SEMOC maintained responsibility for rice breeding and seed production. The country relied on seed produced within its boundaries; imports were discouraged. Despite the fact that there is no competition from imported sources of rice seed, rice seed production was not very profitable, leading the company to abandon breeding efforts. Responsibility of the nation's supply of pre-basic rice seed and testing program was transferred back to INIA. Yet the national research institute had no financial or staffing capacity to pick up this responsibility. The research service does not even have a rice breeder. To make matter worse, SEMOC's stocks of certified rice seed were then lost in the 1999/2000 season floods. INIA must slowly begin to rebuild the country's seed stock from approximately 60 kg of breeder seed.[8].

Similarly, until 1999, the University of Eduardo Mondlane held primary responsibility for groundnut breeding in Mozambique. Again, the lack of resources encouraged the University

[8] The deficiency in domestic rice seed production efforts, and his risks of losing seed to floods or drought, may justify the evaluation and release of more regionally adapted varieties that could be purchased from regional markets.

to transfer this responsibility back to INIA. A single, newly trained Ph.D. agronomist (there are only four Mozambican breeders in the national research institute) must now take responsibility for breeding, and maintain the production of basic seed stocks, for all legume crops. The priorities across crops and programs will need to be carefully evaluated.

Ultimately, there is no payoff to public investments in the development of new crop varieties if the seed is never multiplied and distributed. Investments in crop breeding must be linked with investments in seed production. Since there is little immediate prospect for the commercial multiplication and distribution of many of the varieties developed and tested by INIA, the public sector has little choice but to accept this responsibility.

National breeders must maintain breeder seed supplies. However alternative institutional arrangements may be explored for foundation seed production. The production of some foundation seed stocks may be sub-contracted to the private sector. The assistance of technically competent non-governmental organizations may also be sought. Public investments may be strengthened through the pursuit of at least partial cost recovery. If receipts for the sale of foundation seed can be mandated for reinvestment back into seed production, the capacity of these programs can be expanded.

Regardless of the strategy employed, investment priorities need to be set with care. Decisions about the types of seed to be multiplied need to be linked with a firm understanding of market demand. To facilitate the expansion of this demand, investments in building foundation seed stocks can be linked with targeted demonstration and seed sales programs. Mozambique's priorities for public investment in foundation seed production also need to match the technical capacities of the public sector. Foundation seed must be of consistently high quality to encourage broader investments in seed distribution. If seed quality falters, foundation seed sales, and the capacity to achieve cost recovery, will rapidly decline. Sustainable investments require considered planning.

Recommendations

1. The national research service should be mandated *and financed* to maintain breeder seed of all varieties registered for sale in Mozambique, except those subject to private property rights. Financing needs to include reinforcing the technical capacity of INIA to manage the system.

2. The national research service should be mandated *and financed* to produce, or contract out production of, foundation seed of most registered varieties of proven value to small-scale farmers, and limited commercial interest to the seed sector. At least partial cost recovery should be pursued.

3. The national research service should be mandated to monitor breeder and foundation seed stocks, and distribute an annual report to the National Seed Committee, seed companies, extension services and NGOS identifying new varieties meriting further multiplication and distribution. This should include an estimate of the foundation seed stocks available for further multiplication and a clear description of how these can be obtained.

5. Commercial Seed Multiplication & Distribution is Underdeveloped

Mozambique currently has two major seed companies, SEMOC, a longstanding participant in the seed sector, and PANNAR Seed Limited, a newly registered Mozambican company (as of August 2000) that has significant technical and financial backing from PANNAR-Greytown, a South African company. This compares with the existence of 6 major seed companies in Zimbabwe and over 15 companies in South Africa.

Until late 2000, SEMOC was the only company authorized to produce seed in Mozambique. Despite this monopoly position, during the past five years this company has only been producing seed of maize and rice. Since the majority share of SEMOC was purchased by SEEDCO, the maintenance of even this capacity remains uncertain. In 2000, the vast majority of the seed SEMOC sold was produced outside the country.

In 1999, SEMOC began purchasing sunflower seed from seed producers in Nampula Province, for resale to non-governmental organizations and farmer's associations in neighboring areas. However, late purchases and payments for this seed have placed in doubt the sustainability of this arrangement.

PANNAR was only licensed to produce seed in Mozambique in late 2000, after the start of the 2000/01 planting season. The company appears likely initially to import much of its seed stock from its parent in South Africa. However, PANNAR intends to begin producing seed within Mozambique, with hopes of developing export markets in countries such as Angola (for Mozambican OPV maize) in addition to building its domestic market.

The cotton concessions have maintained responsibility for their own seed supply. They import basic seed, and multiply and distribute it to their own growers. Most seed used, however, is derived from the preceding season's crop. Cotton is not included on the list of crops registered through the National Seed Service, but government regulation stipulates that cottonseed must be distributed for free to cotton growers[9] (Henriques, 2001). Average cotton yields are quite low, in part due to the lack of improved material adapted for Mozambican conditions. The national program has not released any new cotton varieties since 1978. One cotton company, Lomaco, has been carrying out varietal testing over the past five years in collaboration with the French research institute CIRAD[10]. Annual progress reports are forwarded to INIA. This year, they began distributed a new variety better adapted to conditions in Montepuez (Cabo Delgado Province. Under the current system, neither Lomaco or CIRAD can effectively enforce breeder's rights to the new material, nor can it prevent the mixing of the new material with different varietal material provided by other dealers in the same area (Henriques, 2001). Because of the lack of permission to charge for seed and the current regulatory environment, the private sector can only recuperate its investment in varietal development through improved cotton output.

In addition to the two seed companies, Mozambique has more than 15 traders licensed to import seed. Most of these importers simply sell vegetable seed and potato seed, but a few have bid for contracts to sell larger quantities of grain and legume seed in response to the 2000 season floods.

[9] In contrast, cotton seed (for planting) sells in South Africa for around 3 Rands (7000-9000 MT) per kilogram. Cotton seed is sold for industrial use in Mozambique for approximately 1300 MT per kg.

[10] The collaborative program with CIRAD includes back-crossing of local pest resistant traits into varieties from West Africa with higher lint yields.

No significant quantities of seed of crops other than maize, rice and vegetables are sold on the domestic *retail* market. While available data are limited, rough estimates suggest that more than 90% of the seed being distributed for secondary field crops, including sorghum, pearl millet, groundnut, cowpea, pigeonpea is imported for subsidized delivery through relief or development programs. The seed companies and traders do not believe there is significant retail demand for these alternative seed crops. One common assumption is that once farmers have access to an open pollinated variety, they will not return to the market to purchase fresh seed. Instead, seed will simply be obtained from the previous year's crop. However, market data being collected in neighboring Zimbabwe draws this assumption into question.

SEMOC is the largest retailer of seed in Mozambique. During the 1999/2000 season, the company supported 182 active seed retailers around the country. However, the majority of these sell only small quantities of vegetable seed. Moreover, most of these retail seed stockists are concentrated in or near major urban centers (e.g. Maputo, Beira, Nampula), near a few major roads, and in a small number of districts known for high maize output (e.g. Angonia). Thirty-seven percent of Mozambique's 138 districts[11] have no retail outlet selling SEMOC or PANNAR seed (Map 1). Another 34% of these districts have only one seed outlet (Table 7).

Available data suggest that the majority of Mozambique's small-scale farmers have little or no access to commercial seed outlets. And the accessibility of seed to most farmers living in districts containing sales points is poor. While most farmers live in districts with more than one shop, the ratio of farmers to each shop is still over 40,000. This ratio doubles to 83000 households per shop in districts with a single shop. Further, many of these retail outlets are only selling vegetable seed. So the proportion of farmers with good access to retail outlets selling maize seed is quite small.

This problem is not unique to Mozambique. Retail distribution channels for improved seed are similarly limited in most SADC countries. Though Zimbabwe has several seed companies, investments in the development of a rural retail seed trade remain extremely limited. The companies encourage rural traders to purchase their seed stocks from urban wholesalers. They invest little in the development of retail seed trade outside the urban centers. Due to uncertainty about seed demand, most rural retailers similarly only stock maize and vegetable seed.

Yet three questions then arise. What role can the public sector play in promoting, or at least facilitating, the development of the retail seed trade? Moreover, if the commercial seed market remains limited, what alternative channels exist for the distribution of new varieties, particularly of crops other than maize and vegetables? Finally, do distinct strategies need to be developed in less favorable agro-ecological zones where commercial seed retailers are unlikely to invest significantly in establishing retail seed sales?

One strategy contributing to the development of the commercial seed market is to help seed companies better estimate the demand for new varieties. Companies may benefit from better information flow about the quality characteristics, productivity and availability of new varieties tested by the national research institute and non-governmental organizations. Experimental results should be publicized. This includes any evidence of the relative preferences of farmers for alternative varieties. The companies should correspondingly be encouraged to look to INIA for a continuing stream of new, improved varieties.

[11] Defined here as 128 rural districts plus 10 provincial capitals.

The evaluation of commercial demand for seed may also be facilitated by promoting the sale of smaller seed packages. ICRISAT and the SEEDCO have developed a successful program of testing market demand for small pack seed of sorghum, groundnut, cowpea, bambaranut and sugar beans in Zimbabwe. Contrary to the company's expectations, the retail demand for small pack seed has been strong. The demand for various types of legume seed has been particularly high. A similar program was planned for introduction in the northern parts of Manica Province and southern Tete during both the 1999/00 season, and the 2000/01 cropping season. In both years, however, SEEDCO/SEMOC failed to make the seed available. One reason may be because of the strong competing demand for this seed by relief programs.

Commercial incentives to develop retail seed trading networks in Mozambique are also limited by the high transport and management costs characteristic of the national market. This is readily evident in a comparison of retail seed prices in Mozambique with the similar prices currently prevailing in Zimbabwe. Based on official company price lists, the recommended retail prices for the same varieties of maize, sorghum, cowpea and sugar beans are 18 to 48 percent higher in Mozambique than in Zimbabwe (Table 8). Only the prices of groundnut (principally imported from South Africa) were lower in Mozambique than in Zimbabwe. Higher seed prices in part reflect the higher costs of transport and distribution in Mozambique. But these may also reflect the monopoly position of SEMOC in the national market.

Government investments in rural roads can help reduce transport costs. Unit trading costs will also decline with the growth of traded volumes. However, improvements in infrastructure will take many years of investment. In the interim, public-private partnerships to conduct large numbers of demonstrations of improved planting material might help stimulate demand for small pack seed and facilitate company efforts to test this market. By encouraging larger sales volumes, these demonstrations could help companies recuperate part of the costs of expanding retail markets.

The development of commercial seed trade in Mozambique could also benefit from the distribution of relief or development seed through retail trading outlets. Seed companies are happy to pursue larger sales of seed to a few buyers purchasing for emergency programs, and to not to worry about retail seed distribution. Yet this directly discourages the development of seed wholesale and retail trading networks.

To encourage the development of retail trading networks, instead of distributing free seed directly to farmers, extension personnel could distribute seed vouchers for farmers to redeem at retail outlets. This sort of program could encourage farmers to look for seed in retail shops. In addition, this could encourage seed traders to invest in developing a wider retail sales network, particularly to expand into areas in which little to no activity exists.

A voucher approach might also be applied to emergency situations where sufficient retail infrastructure exists. Again, free seed distribution needs to be replaced with efforts to promote retail seed trade. Subsidies can be set contingent on the severity of the disaster in any given area. In areas of severe disaster, vouchers can be valued at the full cost of the seed. In areas with less severe constraints, vouchers may be valued at part of the seed cost. Approximately 22% of the Mozambican population lives in districts susceptible to moderate or severe drought that have more than one shop selling seed (Table 9).

Finally, the seed trade will likely benefit from greater competition in the market. The licensing of new seed companies, particularly those with expertise in variety development and seed production, should be encouraged. One way to do this would be to offer preferential access to government and non-governmental organization seed tenders to companies willing to produce and stock seed of priority varieties in Mozambique.

The seed companies could be encouraged to produce varieties developed or tested by INIA, and found particularly suitable for the nation's farmers.

In general, the implementation of these sorts of development strategies requires closer linkages and better communication between INIA, SNS and all seed companies. Joint planning should be encouraged. Public policy and investments ought to encourage the development of a larger commercial sector rather than competing with this. Complementary investments aiming to assure more farmers better access to a wider range of new varieties should be targeted.

Recommendations

1. The entry of additional seed companies into the national seed market should be encouraged. Domestic investments in seed production and trade should be encouraged through preferential access to tenders for seed destined for emergency or development programs.

2. The distribution of emergency seed trade should be carefully targeted, and to the extent possible, pursued through retail trade establishments where farmers can obtain commercial seed in the future. Farmers should be encouraged to pay at least part of the costs of this seed.

3. Seed companies should be consistently informed of the results of variety development and testing programs. Sales of this seed can be linked with publicly supported demonstration trials.

4. Seed companies should be encouraged to sell small packs to test and develop the demand for seed in the retail market. These should include both well-known varieties and newly registered varieties derived from national breeding programs.

5. Policy makers should monitor the development of the commercial seed market. Priorities for market development should be periodically reappraised.

6. Emergency Seed Supply: Threat or Opportunity for Commercial Seed Market Development?

Mozambique has hosted an emergency or relief seed distribution program almost every one of the past 10 years. Yet historical national data on the quantities of seed being distributed through these relief programs were impossible to obtain. Most of the non-governmental organizations involved in distributing emergency seed maintain records of their individual efforts. But no aggregate data appear to be maintained in the Ministry of Agriculture. In the limited records available, it is sometimes difficult to distinguish between distribution plans and actual deliveries. Since this has been the main source of seed distribution during the past ten years in Mozambique, this is an unfortunate gap in seed sector information.

Very rough estimates obtained through discussions with seed sector participants suggest that during the past 10 years, at least 80% of the cereal and legume crop seed distributed to small-scale farmers in Mozambique has come through relief programs. This includes at least 75% of the maize seed, and 95 % of the sorghum, pearl millet and groundnut seed distributed in the country.

Relief programs have undoubtedly been the single most important source of access to new varieties in Mozambique. Since national records are limited, it is difficult to estimate the number, or even the proportion, of farmers benefiting from these programs. However, surveys conducted by ICRISAT and World Vision in Tete, Sofala, Zambézia and Nampula indicate that in areas where distribution programs were concentrated, virtually all farmers obtained access to relief seed during the peak of the delivery programs in the early 1990s (Rohrbach and Kiala, 2000). Many farmers in the Zambezi Valley were obtaining free seed virtually every year, first as part of the post-war resettlement programs, and later in the context of drought and flood relief programs.

While emergency deliveries may decline in the future, at least limited programs are likely given the high probability of either floods or drought in many parts of the country. Based on national rainfall records, 20 of Mozambique's 138 districts[12] encompass land areas that are highly prone to drought and 30 districts are highly prone to flooding (as defined in CIS (1998) (refer to Table 9). These encompass at least 500,000 households[13]**.** Additional farmers and farming regions are less consistently prone to flooding and drought.

In practice, emergency seed distribution programs offer excellent opportunities to widely distribute new, improved seed varieties, if advance planning can be used to ensure that the right seed stocks are available. Unfortunately, despite more than a decade of experience with these programs, Mozambique remains inclined to re-plan its emergency distribution efforts each year, well after the recognition of a climatic disaster. Due to late planning, efforts are then made to source emergency seed stocks within a few months of the next planting season. Since the national seed market is so underdeveloped, only limited stocks of locally developed varieties are available. The government and donors must then search regional markets for seed of 'acceptable' quality. This includes 'second-best' varieties. For example, the groundnut variety consistently being distributed through emergency programs, Natal Common, is susceptible to the rosette virus. The replacement of this variety with a new less susceptible variety could improve crop productivity even in favorable rainfall years. In some

[12] Ibid.

[13] Based on the assumption that only 50% of the persons living in a district considered highly susceptible to flood or severe drought would actually be affected.

cases, the seed being purchased is simply grain cleaned to seed specifications (for germination). Due to delays in planning, seed commonly arrives late in the planting season.

These problems are exacerbated by exaggerated estimates of emergency seed requirements. While there is no evidence that Mozambique has suffered significant productivity losses as a result of these *ad hoc* strategies, opportunities to get a wider set of better varieties to farmers have simply been lost. Donor subsidies for relief seed need to be better exploited to get new varieties into the hands of small-scale farmers. This requires advance planning of the likely seed requirements needed during the next emergency. A first approximation may be gained from a simple summary of the quantities and locations of seed distributed during past emergencies – if this can be found. Since past evidence suggests these requirements are over-estimated, efforts to verify actual requirements ought to be initiated during future floods and droughts. Table 10 outlines an approximate estimate of the likely requirements for emergency seed in the most drought and flood prone regions of the country, based on 1998/99 production estimates and assuming that all areas would not be affected simultaneously[14] (Map 2). These needs can then be matched with a listing of varieties suited to these areas. This listing may include varieties developed by SEMOC and INIA, as well as varieties of proven value that are available on the regional market.

Existing land suitability databases could potentially serve as a basis for developing more accurate estimates of crop and varietal specific information at the district level. At the present time, the Department of Water and Land in INIA can produce land suitability maps and area estimates for maize, sorghum, millet, manioc, groundnut, sugar bean, and sunflower (Table 11). In the case of maize, separate estimates for two major improved varieties, Matuba and Manica, are based on the distinct differences in growing period for the two varieties. For instance, the model estimates that over 33 million hectares of land in Mozambique are suitable to moderately suitable for the growing of Manica. Varietal suitability data[15] can be combined with digitized data on administrative boundaries, total population, areas susceptible to disasters and cropping pattern data to produce more accurate estimates of emergency (and commercial) seed requirements.

Given the high potential payoff of using relief programs as a conduit of new varieties to farmers, there may be justification for public investments in the maintenance of seed security stocks – particularly stocks of newly released varieties. If the seed is not required for an emergency, it can be sold through commercial channels or used in national variety demonstration plots. Larger seed stocks may be sold as grain. This limits the maximum liability on emergency seed stocks to the difference between seed and grain prices. If the seed stock is used at least once every three years, the maximum liability drops to less than two-thirds of this price difference. If this seed were alternatively sold as seed in the commercial market or to development programs, the potential liability would be substantially smaller than this. The payments for emergency seed can be used to establish a revolving fund for continuing production and stockholding.

[14] For comparison, in response to the major floods in early 2000, 181627 affected families are recorded as having received seed kits for planting for the second season of 1999/2000 (Action Aid, 20 September 2000). With the average kit containing 10 kgs of maize, 3 kgs of cowpea, and 3 kgs of sugar bean seed, approximately 1700 tons of maize, and 545 tons of cowpea, and 545 tons of sugar bean were distributed. Thus, stock estimate needs of 2400 tons of maize, and 719 tons of both types of beans are not widely unrealistic.

[15] Requirements for a land suitability evaluation are extensive. For example, extensive site specific data are needed which associate crop response (yield) with soil fertility conditions, physical soil characteristics, salinity and alkalinity, the topography, drainage conditions (Department of Land and Water, INIA).

Improved planning can also limit the impact of emergency seed distribution on the commercial seed market. The free distribution of seed through relief programs has biased the commercial seed trade toward meeting government and donor seed contracts, rather than building wholesale and retail seed distribution networks. In addition, farmers have become accustomed to receiving free seed. Many do not understand the true value of these seed stocks. Insofar as the quality of some of the 'emergency seed' has been questionable, farmers have gained a misunderstanding of the relative value of new varieties. Packaged seed may be associated with poor germination or 'second best' varieties.

Some of these misperceptions can be resolved by channeling emergency seed through retail sales outlets. Rather than delivering seed to individual villages and farmers, seed can be distributed small-scale village shops. This has two advantages: farmers learn to look for seed in retail shops, and retailers gain an appreciation of the demand for seed. They may then be more likely to continue to stock seed for commercial sale.

Most observers well recognize the need to avoid free seed handouts. Non-governmental organizations are seeking to replace these handouts with the collection of small sums of money or the pursuit of repayments of grain at the end of the season. Yet both strategies are expensive to implement, and rarely work well. One means around this is to provide needy farmers with vouchers. The value of the voucher, and in effect the subsidy on the seed, can then be varied depending on the severity of the seed shortage in any given area. In one district, the voucher may be valued at one-quarter of the cost of the seed, while in another area farmers could be asked to pay one-half the seed price. The retailer can collect the seed payments and vouchers on behalf of the government or NGO program.

An even larger payoff from such programs can be derived if the seed performance and acceptability are monitored. In general, it is only possible to evaluate the success of a new variety once this is widely grown. The monitoring of the broad distribution of emergency seed allows a review of variety performance under more variable environmental and management conditions. Data may also be collected on taste preferences and seed storability. Well-liked varieties may be more broadly promoted for commercial sale. Indeed the evidence of strong demand for a particular variety could be a key stimulus to commercial investments in the production and sales of this seed. Varieties that perform more poorly may be withdrawn from distribution.

In sum, there are substantial opportunities for improving the operations of the national seed system, and the delivery of new varieties to small-scale farmers, using the large subsidies underlying most relief programs. The main challenges are to plan ahead for these opportunities, and to document the resulting experience. If a set of well-defined plans for interventions are already available when the next drought or flood occurs, donor contributions will be more likely. They will certainly be more effective. But this planning must be initiated by the public sector ahead of time. .

Recommendations

Establish estimates of the probability of emergency seed needs for districts of the country prone to flooding and drought. Monitor future distribution programs to more accurately estimate emergency seed requirements.

Identify domestic and importable varieties suited to the districts prone to floods and drought. Advertise these needs among seed suppliers, donors and non-governmental organizations.

Organize a semi-commercial seed security stock made up of varieties newly released through national crop breeding programs that are suited to drought and flood prone regions. This should encompass a shifting array of varieties registered for distribution in the country and be implemented in collaboration with seed companies.

Organize a pilot seed voucher program encouraging the distribution of 'emergency seed' through retail shops. This should be a joint venture with one or more seed companies.

7. Blurred Boundaries: Involvement of Smallholder Farmers in Commercial and Non-Commercial Seed Production

Limitations in the quantity of seed available on the market in Mozambique have encouraged several non-governmental organizations (e.g. World Vision, CARE, Food for the Hungry, AFRICARE), as well as several provincial extension services (GTZ/SPA Sofala, DANIDA/SPA Tete, Cooperação Suiçã/SPA Nampula), to undertake projects to produce seed at the community level. These programs are of two general types: 1) promoting production of seed crops of little interest to the private sector, and 2) those promoting production of seed crops of potential commercial value. Most of these projects aim to get farmers involved in the process of seed production and storage. This creates the chance to teach farmers about seed quality, and introduces farmers to a wider range of new varieties. In some cases community seed production may also offer the opportunity to improve rural incomes. Seed production may then be promoted as a cash crop for sale to neighboring communities or to the commercial market.

The first type of program is commonly referred to as community seed production for "local" distribution or sale. The second type has emphasized the production of certified seed by either individual growers or associations, with the eventual goal of having private seed companies or commercial grain traders contract the seed production. Thus, under the second scenario, these seed producers eventually become part of the "formal" or commercial seed sector.

Non-Commercial Seed Production

The record of local seed production initiatives in southern Africa is highly variable (Tripp, 2000). The most commonly voiced concern is the need to maintain a reasonable standard of seed quality. This leads to an emphasis in technical assistance programs on production training and proper isolation of fields. However, there remain debates about how much quality control is necessary. Many farmers would prefer to purchase cheaper seed of reasonable quality, compared with more expensive, certified seed.

An additional problem facing most of these programs is the question of seed marketing strategies. Larger groups of seed producers within a single community almost invariably turn to the non-governmental organization or public extension service for assistance with seed marketing. In most cases, the non-governmental organization either purchases the seed itself, or finds another external buyer. This has encouraged the testing of new strategies for producing smaller quantities of seed in many more communities.[16]

These programs rely on public subsidies to supply foundation seed, support training, monitor production and facilitate marketing. This has led to questions about their sustainability. While seed production targets have commonly been achieved, communities have become dependent on external assistance.

Ultimately there may be some seed crops than can be commercialized and others that cannot. Objectives relating to promotion of the distribution of new varieties, increasing the diversity of crops grown or improving seed security may warrant a continuing public subsidy. These projects may be useful for assessing the prospects for commercialization of any given seed

[16] For example, two programs in Tanzania are encouraging production of only 1-2 tons of seed per community. These specifically aim to avoid production of more seed than a community can sell or distribute within its own boundaries.

crop. If commercialization appears practical, public investments may help establish a foundation for sustainable seed markets.

For example, the GTZ is working with the provincial directorate of Agriculture in Sofala to promote the testing of a range of new varieties. This includes support for demonstration trials of a range of different varieties and then small-scale seed production of varieties of particular interest to local communities.

Most vegetatively propagated material, such as manioc and sweet potato, are unattractive to the private sector because they are so easily multiplied and distributed through informal farm community trade networks. Here again, public support offers a means to quickly distribute new varieties. The potential yield gains possible from distributing currently known improved materials within Mozambique are enormous. As shown in Table 1, if yield levels could be raised on average from the current estimate 5,8 tons per hectare to 7,8 tons per hectare, an additional 2 million tons of cassava could be produced, valued at 2200 billion MT ($180 million USD). Clearly not all farmers obtaining higher yields would opt to keep the same amount of land under cassava production. In these cases, additional land and labor could be dedicated to other crop or livestock activities.

Community based multiplication of sweet potato in Mozambique is currently a joint undertaking of the SARRNET, INIA, various non-governmental organizations and smallholder associations. The effort is an excellent example of how promising new varieties can be financed and distributed through emergency efforts as well as development programs (Low, et al. 2000). First generation multiplication plots are typically based at research stations or sites with greater management capacity (for example, agricultural schools) as more management intensive rapid multiplication techniques are commonly employed. The second round of multiplication is pursued at secondary sites nearer target communities using conventional multiplication methods. The third round of multiplication involves a large number of small-scale sites managed by community groups, leading farmers, schools or other local institutions. These serve to supply source material to individual farmers. Typically, the planting material is either sold at a low price to compensate site providers, or given away.

The community seed production strategy being pursued by World Vision is more market oriented. In 1997, this organization began providing farmers in Nampula and Zambézia Provinces with credit for seed production inputs, and deliberately assisted with seed processing and marketing. Three problems have been encountered. First, farmers in these regions had become accustomed to receiving free seed from World Vision, and were reluctant to then start paying for this input. Second, questions arose about the right of the non-governmental organization to assist with the sale of uncertified seed. Third, questions arose about the right of World Vision to encourage the production and sale of seed of varieties sought by farmers, but not yet officially released. Some extension agents were hesitant to promote these sales. World Vision interprets the law to allow sales of uncertified seed among its own project participants.

Some local seed producers are seeking to expand their markets – selling to communities outside of their neighboring communities. This gives farmers an option to purchase unimproved or common seed from neighbors, or *improved,* but uncertified seed from farmers participating in such NGO seed projects. In the process, the distinctions between *informal* and *formal* seed production systems begin to blur. There may be a need to legalize the broader sale of *improved, uncertified* seed. This will encourage traders and shops to begin

selling seeds, and thus test opportunities for development of a commercial market. Commercial seed companies may be encouraged to market those varieties with strong sales.

These programs offer an excellent means to test demand for newly released varieties. National breeding programs can take advantage of the investments being made by community seed projects to collect a wider range of data on variety performance and acceptability. These data could then be used to encourage private seed companies to commercialize varieties with the strongest levels of consumer demand. However, the record offered by community seed programs to date suggests continuing public investments will still be required to promote on-going distribution of seed crops with limited commercial demand.

Seed Production for the Commercial Market

Community seed projects may also encourage farmers to produce seed crops for sale by commercial seed companies or grain processors interested in expanding the production of particular varieties. The seed may be purchased by a seed company or grain trader who would then take responsibility for packaging and sale. In favorable cases, the private sector may take over the function of multiplying and distributing foundation seed and providing backstop technical assistance to ensure seed quality control. In other cases, public investments may be justified as a means to promote larger investments in crop trade.

CARE is currently undertaking this sort of program for sunflower and sesame seed production in Nampula province and AFRICARE has a similar program in Manica province. Both NGOs provide transport necessary to ensure that the National Seed Service conducts field inspections. They also encourage farmers to organize their fields in blocks to permit certification inspections at the lowest possible cost. All seed sold within these schemes, whether by the NGO or their private sector partners, is guaranteed.

In a similar example, Swiss donors have been financing the provincial directorate of Agriculture in Nampula to promote pigeonpea seed production since 1998/99. The promotional package typically includes foundation seed, pesticides, storage chemicals and improved management practices. The inputs are subsidized 100% the first year, 50% the second year, and sold at full cost the third year. These investments help develop the rapid expansion of pigeonpea grain production for sale to buyers in Malawi and South Africa. The non-governmental organization CLUSA has been asked to facilitate access to these markets.

The experience of these programs has been mixed. Private companies asked to assist with the purchase and redistribution of the seed have displayed variable commitment to these programs. Nonetheless, early experience suggests this model is promising for crops identified to have high export or domestic market potential.

Initiatives to develop both commercial and non-commercial strategies for community seed production need to be recognized as essential components of the national seed system. Each of these strategies has strengths and weaknesses. Each may be suitable for different types of seed crops and distribution objectives. These models are still evolving. Each year more experience is being gained.

Insofar as these programs involve a growing commitment by government and non-governmental organizations, they ought to be monitored and ultimately evaluated. Performance indicators need to be explicitly defined, and well known to each of the

stakeholders involved in the planning and implementation of these programs. Here too, the Ministry of Agriculture has an important leadership and coordinating role to play.
The need for substantial commitment to long-term public support for more successful strategies is great.

Recommendations

1. Community seed production should be explicitly recognized as a component of the national seed system. These projects need to be recognized in national development programs as valuable opportunities for distributing newly released varieties to more farmers and testing the demand for new varieties.

2. Agencies interested in increasing smallholder participation in seed production should first assess whether significant commercial potential exists for the seed in question. Policy makers and planners need to accept that for some crops (for example, cassava) and in some isolated areas, the public sector will need to continuously invest in seed production to assure the dissemination of new varieties at the community level.

3. Ten to fifteen years of public investment is required to train smallholder seed growers for contract production schemes, establish quality standards and test alternative marketing strategies for seed crops of greater commercial potential. Non-governmental organizations can play a crucial role in brokering relationships between seed companies and seed growers or traders.

4. A clear policy should allow the sale of uncertified seed through commercial trade channels. Farmers should be allowed to choose whether to pay more for certified seed or less for uncertified, but truthfully labeled (using graphic designs as well as words), seed.

8. Role of Regional Seed Trade in Promoting Mozambique's Seed Sector

Mozambique has historically depended on seed imports for the majority of its seed supplies. While domestic production of maize seed temporarily rose above the national requirement during the early and mid-1990s, this has now declined to relatively small levels. The country has also attempted to be self-sufficient in rice seed production. However, presently the country is facing a serious lack of rice seed adapted to irrigated areas because of the complete loss of 230 tons of certified rice stock during the 2000 floods (Dimande, personal communication). During the 2000/01 planting season, Mozambique is estimated to have derived over 95% of its commercial seed supplies from the regional market.

The main cost of dependence on seed imports is that farmers lose access to varieties developed in Mozambique that are well-suited to the nation's agro-ecology. In the case of maize farmers have access to only two open pollinated varieties, and face seed companies concerned to promote the sale of hybrids. Though five groundnut varieties are on the newly drafted variety registration list, only one of these, Natal Common, is available for sale or distribution in the country. And this variety is prone to the rosette virus. Though there are 14 varieties of cowpea identified on the variety registration list, only two of these are is available for sale or distribution in the country. In each case the entire seed stock is derived from neighboring countries.

While an independent national seed industry may offer an ideal means to assure farmers have access to varieties best suited to their local environment, the development of a competitive industry encompassing all crops is impractical for most developing countries. Mozambique, and most other countries in southern Africa, are off best pursuing a complementary strategy of reliance on regional seed trade while developing their domestic seed industries. The mix of seed crops best produced in-country, and those competitively supplied in the regional seed market, will evolve with time. A clear and flexible seed trade strategy must allow for this.

This endeavor should start from the recognition that many of the varieties registered for sale in neighboring countries are reasonably well suited to Mozambique's production zones. Available information indicates that approximately one-half of the varieties on the newly drafted registration list originate from breeding programs outside the country. In addition some of the varieties selected by breeders in Mozambique derive from germplasm originally developed and tested in neighboring countries.

For example, the sorghum variety Macia originated from germplasm provided by ICRISAT in the late 1980s. This variety was originally released in Mozambique in 1995, and has since been registered for sale Botswana, Namibia, Tanzania and Zimbabwe. Large-scale multiplication of Macia seed is underway in Zimbabwe for sale across SADC countries. The cowpea variety IT 18 was similarly derived from germplasm developed by IITA. This variety is currently being produced in several countries including Zimbabwe and South Africa. Many of the maize hybrids developed by PANNAR and SEEDCO in neighboring countries seem to perform well in Mozambique.

This is not to suggest that Mozambique should give up its breeding programs for these crops. INIA or SEMOC can still identify better varieties suited to the unique needs of the Mozambican agro-ecology, particularly for lower altitude areas. But in the meantime, the country can gain from making use of the best available germplasm in the SADC region.

Seed trade should be particularly encouraged in crops for which INIA does not have active breeding programs. At the moment, the national research system only has four active breeders. Breeding programs exist for maize, some of the legumes, roots and tubers and cashew. Yet even these programs are heavily dependent on germplasm and varieties developed outside the country. The methodical evaluation of varieties developed and released in neighboring countries offers an efficient starting point for small national breeding programs.

National efforts can complement regional breeding programs by concentrating on the development of varieties particularly suited to Mozambique's more unique environments. For example, Mozambique can take advantage of the early maturing sorghum varieties developed by the SADC/ICRISAT program in Zimbabwe, while concentrating on developing its own later maturing sorghum varieties suited to the unique environments of Nampula and Niassa.

Mozambique can also take advantage of the capabilities of seed companies in neighboring countries by encouraging them to target its requirements. Mozambique already relies on the regional market for relief seed. If these requirements are well defined, and advertised across the region, regional seed companies will gain a higher incentive to maintain seed stocks of varieties more suited to Mozambique's agro-ecological environment.

In order to take better advantage of the regional seed market, Mozambique needs to participate fully in SADC's efforts to harmonize seed regulations.[17] Particular attention may be directed toward eliminating unnecessarily strict phytosanitary barriers to trade. In this context, a comment is merited on how seed trade may be affected by the enforcement of phytosanitary standards. These constitute a main point of argument underlying the harmonization of seed regulations and promotion of seed trade in the SADC region. This is a main reason why these harmonization discussions have been underway for more than a decade.

Most observers agree that the regulatory standards currently guiding seed trade in southern Africa are too strict. Phytosanitary standards are particularly strict. Yet many of these regulations are probably unnecessary. When phytosanitary regulations were closely examined in a recent set of meetings chaired by ASARECA in eastern Africa, an initial listing of more than 50 phytosanitary restrictions was ultimately reduced to three. In some cases, restrictions were in place for diseases that are not seed borne. In other cases, restrictions were requested for diseases that do not exist in east Africa. Once the discussion agreed on the objective of promoting seed trade, rather than restricting seed movements, the barriers came down. Similar agreements should be attainable in southern Africa.

While Mozambique seeks to implement a series of quality restrictions on seed imports, in practice, these restrictions are almost impossible to enforce. During the past decade, seed has commonly been imported into the country without strict quality controls. In some cases, grain has been imported, and sold as seed. This grain still meets basic germination standards. But it is not as pure as a crop grown for seed. Nor is it subject to strict phytosanitary controls during production. Yet there is no evidence that the productivity of Mozambique's farmers has been compromised as a result of these imports. Instead, Mozambique's farmers have substantially gained from the *de facto* reduction in barriers to trade.

[17] Currently there are several different initiatives promoting the harmonization of seed laws and regulations in southern Africa. Similar efforts are underway in eastern Africa and West Africa.

Ultimately, a limited subset of phytosanitary requirements may be useful to maintain. But it may be more practical to enforce these standards at the borders of SADC than in trade between neighboring countries. In practice, intra-regional trade should only be limited when there is a high, and measurable, risk associated with the spread of a particular disease. Otherwise, the preponderance of evidence suggests the need to pursue the reduction of regulatory barriers in order to facilitate larger and more efficient trading practices.

Recommendations

1. Mozambique should actively work with SADC to harmonize seed regulations with the objective of promoting greater regional seed trade.

2. Actively seek out varieties performing well in neighboring countries for testing and possible distribution in Mozambique.

3. Encourage regional companies to produce and maintain stocks of varieties suited to Mozambique's drought and flood prone areas.

9. Seed Quality Control: Finding a Balance between Theory and Practice

Seed quality regulations aim to protect farmers from unscrupulous traders offering poor quality seed or planting material. This includes seed with low germination rates, seed carrying diseases and seed of impure varieties. Since these traits are often difficult to distinguish on the seed product itself, regulations commonly involve a costly set of field and laboratory inspections. These raise the cost of seed and delay seed imports. The key question is: how much quality control is necessary?

A trade-off exists between the costs of enforcing strict standards of seed quality, and the benefits of more liberal marketing practices. Mozambique's seed regulations generally limit the sale of seed of less than 90% purity and 75-90% germination (depending on the crop). Yet farmers themselves commonly trade seed of much lower levels of purity and germination. The limited development of commercial seed markets in most of Africa, partly reflects the willingness of farmers to use lower 'quality' seed saved from their previous crop, or obtained from neighbors, rather than purchasing more expensive, pure seed stocks. Many farmers in the industrialized countries are similarly satisfied to pay lower prices for lower quality seed obtained from smaller, local companies, rather than paying high prices for extremely pure seed from the larger multinational companies.

Farmers may be better off with the opportunity to choose what quality of seed they are willing to pay for. In this context, knowledge of the quality attributes of seed being marketed is probably more important than the level of the standard *per se*. Growing recognition of this fact has led to an expanding acceptance of the concepts of quality declared and truthfully labeled seed. Higher payoffs may also be derived from educating traders and farmers about the variability of seed quality, rather than preventing access to seed because this fails to meet unnecessarily high standards of purity and germination.

Some argue that the low levels of education of small-scale farmers in countries like Mozambique still justifies the maintenance of strict regulatory standards in order to protect the consumer. Yet these same standards are generally relaxed when emergencies arise. This is not an explicit decision. It is simply impossible to enforce strict quality controls when massive quantities of seed must be imported at short notice. In fact, Mozambique's farmers would have been hurt if these standards had been enforced. Much of the seed supplied through relief programs would never have been allowed across the border. Did farmers suffer for this lapse? There is no evidence for this, and substantial evidence that farmers were better off with a freer seed trade.

In a related problem, governments should generally avoid linking the enforcement of seed quality standards with the opportunity of seed regulators to obtain income. This is not an appropriate area for cost recovery. If seed regulators gain much of their operational income from the number of inspections they carry out, they face an incentive to pursue more inspections, and call for stricter standards.

By corollary, seed inspection units should be fully funded as a service to the seed industry. At the same time, the quality of service of seed inspection units should be monitored with the assistance of the broader industry. If the seed industry feels that it is gaining good service from the inspectorate, it is more likely to utilize and support the facility. There is less incentive to by-pass the system. But if quality control becomes a burden, seed producers and seed traders will seek to avoid it.

Finally, there is little question of the need for Mozambique's SNS to be strengthened. But as long as resources are limited, the seed quality control targets for these investments need to be prioritized. It is virtually impossible for Mozambique's seed services unit (SNS) to supervise seed storage and sales practices of the 182 retailers currently operating for SEMOC. Nor can the seed services unit be expected to inspect every field being planted to seed under various provincial and NGO led seed production projects. While the SNS laboratories need to be strengthened to help monitor the seed trade, more substantial commitments might be made to implementing educational campaign on seed quality. Moreover, training and licensing of extension agents to carry out field and sale point inspections would increase the capacity to monitor seed quality at lower cost. Again, a primary objective should be to facilitate the production and trade of higher quality seed, not simply to police this trade.

Recommendations

1. Mozambique should promote truth in seed labeling rather than a single, strict set of quality standards.

2. Mozambique should adopt FAO proposed standards for quality declared seed. This class of seed should be promoted in commercial market transactions.

3. The national seed services unit should not be mandated to achieve full cost recovery.

4. Higher levels of seed quality should be pursued through educational campaigns, and not simply the policing of seed production and trade. Seed regulators can lead the development of such programs.

10. Dialogue Needed for Active Seed System Development

The level of discussion about seed system development remains limited in Mozambique. Open debate about the development of the sector is not encouraged. Little information about seed sector performance is collected, and access to public sector data that do exist is frequently restricted. The national seed committee (Comité Nacional de Sementes or CNS) rarely meets. In consequence, little progress has been made in implementing the National Action Plan on Seeds formulated at the June 1999 stakeholders workshop on seed system development.

The Comité Nacional de Sementes is mandated to articulate a public investment strategy for promoting the efficient delivery of seed to farmers throughout the country. Rather than concentrating on regulations governing the sector, this Comité can lead efforts to promote broader dialogue.

A good starting point for this national dialogue is to establish a clear set of indicators for seed system performance. Does breeder and foundation seed exist for all registered varieties? Are these varieties being multiplied and distributed to farmers? Do more farmers have ready access to seed, either through community seed programs or the commercial market? Is this seed affordable and of acceptable quality? Are adoption rates rising?

The Comité Nacional de Sementes ought to annually review progress in the implementation of the national seeds action plan. This progress may be best assessed in an annual workshop on seed sector performance. Such a meeting can bring together all major stakeholders in the seed sector including government agencies, seed companies, non-governmental organizations, and donors. These stakeholders can then jointly be held accountable for the implementation of the seed plan of action.

Dialogue about seed sector development can also be facilitated by the wider collection and distribution of information about sector performance. All stakeholders should have ready access to information about variety availability, seed distribution and adoption rates Information about possible changes in regulations should be widely debated. The results of pilot programs to test alternative seed production and marketing strategies should be broadly shared. To achieve this, investments in data collection and dissemination need to be prioritized and the persons responsible specified.

Recommendations:

1. The Comité Nacional de Sementes should meet at least twice each year to review the performance of the seed sector, and set public investment priorities for the development of the sector. The Committee should issue semi-annual progress reports on system performance.

2. The Comité Nacional de Sementes should sponsor annual stakeholder meetings to assess progress on the implementation of the Action Plan for the Seed Sector. These meetings can also be used to promote broader discussion of possible changes in seed laws or regulations.

3. Consideration may be given to the establishment of a dedicated group of stakeholder representatives to regularly monitor and review the seed action plan. A Seed Coordinator

committed to a multi-sectoral, partnership approach to accelerate seed sector development should lead the group.

4. Information about seed sector performance should be more deliberately collected and disseminated to all stakeholders. This may include distribution through the Rural Extension magazine, the newsletter *Folhas Verdes*, the Monthly Bulletin of the National System for Agricultural Markets (SIMA) and a Mozambique seed system development *list site* on the Internet.

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Tables

Table 1. Estimated Additional Annual Net Benefit from Distribution of Improved Seed Alone Based on Purchasing Seed Only Once Every Three Years in Mozambique (Based on yield increases of 25% for grains & grain legumes; 35% for roots and tubers and 1998/99 prices and estimated yields and hectares harvested)[1]

Crop	Estimated Area Harvested ('000 Hectares)	Estimated Annual Net Additional Benefit from Improved Seed		Percent Contribution to Total Increase	Three Most Important Provinces for Improved Material
		(Billions (10^9) of MT)	(Millions (10^6) of USD)		
Manioc	964	2.233,3	180,1	68,6	Nampula, Zambézia, Cabo Delgado
Open Pollinated Maize	1152	362,1	29,2	11,1	Manica, Zambézia, Tete
Groundnuts	262	242,9	19,6	7,5	Inhambane, Nampula, Tete
Sorghum	461	156,3	12,6	4,8	Nampula, Zambézia, Tete
Beans	370	108,2	8,7	3,3	Cabo Delgado, Tete, Nampula
Rice	170	79,8	6,4	2,5	Zambézia, Sofala, Gaza
Sweet Potatoes	27	56,8	4,6	1,7	Zambézia, Maputo, Manica/Sofala
Millet	96	17,5	1,4	0,5	Tete, Zambézia, Manica
TOTAL	**3504**	**3.257,0**	**262,6**		

[1] Additional Net Benefit is the average of three years of additional value (output price X higher yield *minus* current value) *minus* the cost of the seed purchased in year one. Except for sweet potato, estimates are based on provincial level area and yield estimates from the Early Warning System (Ministry of Agriculture and Rural Development) for 1998/99. Output price data are actual figures from SIMA (MADER) or the national accounts estimates and seed price data are from SEMOC for grains and grain legumes. Exchange rate in 1998/99 was 12400 MT/ $1 USD. See Annex 1 for further detail.

Table 2. Annual Additional Net Benefit by Province and by Household in Each Province Accruing from the Distribution of Improved Seed in Mozambique

Province	Number of Rural Households[1]	Percent of Total Annual Additional Benefits	Net Annual Additional Benefit per Household	
			Meticais	USD
Niassa	151.369	3,3	700.585	56
Cabo Delgado	286.506	12,2	1.391.608	112
Nampula	620.560	37,5	1.966.722	159
Zambézia	639.375	23,7	1.205.653	97
Tete	231.800	4,0	559.113	45
Manica	148.187	3,6	798.722	64
Sofala	164.548	2,9	581.232	47
Inhambane	207.596	7,2	1.135.819	92
Gaza	174.914	3,5	660.873	53
Maputo	74.035	2,0	890.042	72
TOTAL	**2.698.890**	**100**	**1.206.781**	**97**

[1] Based on 1997 Census data, National Institute of Statistics (INE).

Table 3. Sowing Rates, SEMOC Seed to Output Price Ratios and the Total Cost to Plant One Hectare in the 1998/99 Season (Averages at National Level).

Crop	Sowing Rate (kg/ha)	Cost of SEMOC Seed in 1999 (MT/kg)	Seed to Output Price Ratio (1998/99)	Cost of Seed for Planting One Hectare in 1998/99 Season	
				MT	USD
Millet	5	9990	6,7	49950	4,0
Sorghum	8	8850	4,1	70800	5,7
Maize	20	7900	4,7	158000	12,7
Beans (Cowpea)	30	11400	4,8	342000	27,6
Sugar Beans	60	23000	3,5	1380000	111,3
Groundnut	75	16600	3,9	1245000	100,4
Rice (broadcast)	120	5950	2,4	714000	57,6

Table 4. Seed varieties registered and available for sale in Mozambique, December 2000.

	On National List of Registered Varieties in 1995	Dropped in Revised List	Added to National List	On Revised May 2000 List	On Revised List with Breeder Seed Available within Mozambique	On List Being Sold Commercially 2000	NOT on List but Being Sold Commercially	Number of Commercialized Varieties that are Only Imported
Maize	27	11	4	19	12	5	9	16
Sorghum	12	10	1	3	3	2	0	2
Millet	0	0	3	3	3	0	1	1
Rice	12	3	1	10	10	5	0	0
Beans (*vulgar)*	20	7	0	13	9	4	0	3
Cowpea	26	12	0	13	5	1	1	1
Groundnut	16	12	0	4	2	1	0	1
Pigeonpea	1	1		0	0	0	1	1
Sunflower	6	4	0	2	1	2	1	2
Sesame	0			0			1	0
TOTAL	120	60	9	67	45	20	14	27

Table 5. Examples of the proportion of domestically developed and internationally developed varieties of major crops on the 1995 registration list

Crop	Number of varieties domestically developed	Number of varieties imported
Maize	16	11
Sorghum	6	6
Sunflower	0	6
Groundnut	5	11
Soyabeans	0	8
Beans (vulgar)	16	4
Cowpeas	24	2

Table 6. Availability of breeder and foundation seed for varieties developed by INIA or the Faculty of Agronomy

Crop	**Variety**	**Breeder Seed**	**Foundation Seed**
Maize	Manica	Yes	Yes
	Matuba	Yes	Yes
	Obregon Flint	Yes	No
	Umbeluzi	No	No
Sorghum	Chokwe	Yes	No
	Macia	Yes	No
	SV 2	Yes	No
Pearl millet	RMP 1	Yes	No
Groundnut	RMP 12	Yes	Yes
	Bebiano branco	Yes	No
	Bebiano encarnado	No	No
Rice	C4 63	Yes	No
	IR 52	Yes	No
	IR 64	Yes	No
	ITA 212	Yes	No
	ITA 312	Yes	No
Beans (vulgar)	INIA 10	Yes	No
	INIA 12	No	No
	Calima	Yes	Yes
	Unvoti	Yes	No
	Encarnado	Yes	No
	Manteiga	Yes	Yes
	PVA 773	Yes	Yes
	Multimanteiga	Yes	No
	INS 2	Yes	No

Table 7. Availability of Retail Shops Selling SEMOC or PANNAR Seed at the District Level[1] in Relation to Total Population and Number of Households[2]

Category	No. of Households	% of Total Population	Number of Districts
Districts with more than one shop selling seed	2123183	63	40
Districts with one shop selling seed	835142	23	47
Districts without a shop selling seed	627774	14	51
Total	**-**	**-**	***138***

[1] Districts comprise 128 rural districts plus 10 provincial capitals.
[2] Based on Year 2000 data for SEMOC; 2001 data from PANNAR. 1997 Census District Level Population Figures.

Table 8. Retail seed prices in Mozambique and Zimbabwe (per kilogram converted to US$)

Crop	Mozambique a/	Zimbabwe b/
Hybrid maize	0.89	0.75
Sorghum (Macia)	0.68	0.46
Cowpea (IT 18)	1.04	0.72
Sugar beans (bonus)	1.67	1.31
Groundnut (Natal common)	1.32	1.62

a/ SEMOC recommended prices per kilogram based on 25 kg pack size
b/ SEEDCO recommended prices per kilogram based on 5 kg pack size, except maize

Table 9. Approximate number of districts, families, and percentage of total population living in districts where at least part of the area is subject to flood or drought by relative availability of retail shops selling SEMOC or PANNAR seed.

Category			Districts without a Shop Selling Seed	Districts with one Shop Selling Seed	Districts with more than one Shop Selling Seed	**TOTAL**
Floods	High Risk	No. of Districts	5	7	18	**30**
		No. of Households	75959	137619	501179	**714757**
		% Total Population	2.1	3.9	14.8	**20.8**
Drought	High Risk	No. of Districts	5	4	11	**20**
		No. of Households	36895	36304	209868	**283067**
		% Total Population	1.2	1.1	6.6	**8.9**
	Moder-ate Risk	No. Districts	5	11	22	**38**
		No. of Households	92642	171388	512092	**776122**
		% Total Population	2.6	4.2	15	**21.8**
High Risk of Floods and Drought		No. of Districts	0	0	7	**7**
		No. of Households	0	0	151311	**151311**
		% Total Population	0	0	4.8	**4.8**
Other Districts (Without severe risks)		No. of Districts	21	20	26	**67**
		No. of Households	430863	521062	1099933	**2051858**
		% Total Population	10.7	13	28.1	**51.8**

Note: The column sums of percentages exceed 100% because of the existence of households who can fall in more than one category concurrently (for example, moderate risk of drought in one part of the district, risk of flooding in the other).

Table 10. Estimated quantities of commercial and basic seed needed to meet 50% of the estimated needs of districts prone to severe drought or severe flooding (mt) a/

Crop	Commercial seed a/	Basic seed b/
Maize	2051.1	49.8
Sorghum	460.4	4.2
Millet	117.1	0.8
Beans	889.8	41.8
Rice	2266.5	214.8
Groundnut	1619.4	192.2
Note: for manioc, the values are expressed in hectares of planting material:		
	Conventional Multiplication	Rapid Multiplication
Manioc	3.191	106

a/ Vulnerability assessments (subject to severe drought or high risk of flooding) at district level from the 1998 Structural Data for Districts of Mozambique conducted by MSF-CIS.
b/ Based on district production estimates by crop for 1998/99 from Sistema Nacional de Aviso Prévio; 50% reduction of requirement based on assumptions that the entire district will not be affected by the disaster and affected farmers will be able to retain some of their own seed. The following seeding rates were used to calculate needs: maize (20 kg/ha); sorghum (8 kg/ha); millet (5 kg/ha); beans (30 kg/ha); rice (120 kg/ha); groundnut (75 kg/ha); manioc (30:1 for rapid multiplication; 10:1 for conventional multiplication).

Table 11. Estimated potential area (in Hectares X 1000) suitable for different crop cultivation in Mozambique[1]

Crop (Specific Variety)	Very Suitable	Suitable to Moderately Suitable	Marginally Suitable	Conditionally Suitable	Not Suitable
Maize (Matuba)	656	7.780	37.530	83	26.796
Maize (Manica)	686	33.004	15.282	166	23.707
Manioc	451	20.344	16.067	1.068	34.916
Sorghum	4.393	28.611	29.990	472	9.380
Millet	3.233	38.324	16.172	274	14.841
Groundnut	160	13.717	39.528	1.352	18.087
Sugar Bean	0	1.586	49.136	0	22.123
Sunflower	15	7.013	49.622	0	16.194

[1]Source: Department of Land and Water, INIA. Calculated areas exclude areas occupied by national parks, game reserves, forest reserves, and bodies of water. Conditionally suitable means that the land could be used *if* a constraint was overcome (for example, introducing irrigation).

Annex 1. Additional Annual Net Benefit (mil contos (10^6 MT)) from Distributing Improved Seed Alone by Province (Annual Average over Three Years, Assuming Single Purchase of Seed; Evaluated at Estimated 1998/99 Cultivated Areas per Province and Producer Prices)[1]: Detailed Data underlying Table 7.1

Province	Manioc	Maize	Groundnuts	Sorghum	Beans	Rice	Sweet Potato	Millet	TOTAL
Niassa	49.347	28.906	1.227	11.293	7.799	5.771	1.413	287	106.046
Cabo Delgado	314.870	12.115	22.808	15.766	***26.479***	5.836	108	718	398.704
Nampula	***1.079.525***	33.156	*41.162*	***42.795***	16.169	6.059	344	1.256	1.220.469
Zambézia	*589.202*	*49.130*	30.024	*21.644*	14.958	***38.515***	***25.008***	2.379	770.864
Tete	2.921	48.355	34.832	20.405	*16.612*	28	1.010	***5.435***	129.602
Manica	3.001	***87.406***	5.268	13.679	1.453	96	5.094	*2.359.*	118.360
Sofala	23.820	29.272	4.795	19.556	3.414	*8.562*	4.011	2.207	95.640
Inhambane	113.708	39.425	***63.175***	7.533	9.752.	297	127	1.770	235.791
Gaza	47.735	16.605	28.457	3.243	8.095	7.513	2.872	1.073	115.596.
Maputo	9.196	17.690	11.176	396	3.496	7.137	*16.799*	0	65.894
TOTAL (10^6 MT)	2.233.330	362.065	242.928	156.315	108.230	79.818	56.791	17.488	**3.256.969**
TOTAL (10^6 USD)	180,1	29,2	19,6	12,6	8,7	6,4	4,6	1,4	262,6
% Increase over Current Gross Value	28	21	41	23	40	16	30	23	

Assumptions (1998/99 season):

Estimate of Cost of Planting Material per ha (MT)	1860000						930000		
Sowing Rate (kg/ha)		20	75	8	30	120		5	
Price of Seed -MT (SEMOC 1999)		7.900	16.600	8.850	12.908	5.950		9.990	
Average National Output Price (MT/kg)	1.447	1.668	4.274	2.142	2.399	2.503	1.149	1.501	
Seed/Output Ratio	4,5	4,7	3,9	4,1	5,4	2,4	6,7	6,7	
Total Area Harvested (ha)	964.572	1.152.155	262.384	461.454	370.280	170.385	26.862	95.581	
Average Current National Yield (kg/ha)	5,79	0,95	0,55 unshelled	0,68	0,49	1,15 unshelled	5,43	0,62	
Yield with Improved Seed (kg/ha)	7,82	1,19	0,69	0,85	0,61	1,44	7,33	0,78	

[1] Areas and yield estimates from SNAP (Early Warning system) for 1998/99 are very rough, except for sweet potato. For sweet potato, combined data from TIA 1996 (National Agriculture Survey) on average plot size with consumption data from the National Household Living Standards Survey. Assumed 25% yield increase with improved seed for grains and grain legumes, based on discussions with breeders; assumed 35% yield increase from improved manioc & sweet potato varieties. Yield data used in calculations based on yield estimates at the provincial level. Price data based on average of monthly data from the National Market Information System (SIMA) for maize, beans, rice & groundnut. Used estimate prices from the National Accounts (National Statistics Offices) for remaining crops, except sweet potato. Sweet Potato prices from informal survey conducted by INIA/MISAU/HKI in 1997. Sowing rates from SEMOC sales documents. Estimated cost of cassava and sweet potato planting material based on personal communication from the Southern African Roots & Tubers Network.

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